Shippers' Responses Changes in Transportation Costs and Times:

The Mid-American Grain Study

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Introduction

- Navigation projects necessitate an assessment of costs and benefits.

- Benefits of projects depend heavily on
  - Assumptions related to demand
  - Forecasts of future traffic on the waterway

- Cost/benefit studies are scrutinized heavily, and planning models use to calculate benefits criticized for:
  - The assumptions made on demand; and
  - The level of forecasts used to predict future traffic.

National Research Council (2004)

"Price responsiveness is so important to estimating the benefits of waterway improvements that informed judgments about the merit of the waterway improvements cannot be made without careful study of demand and supply elasticities"

Purpose of Research

To measure responsiveness of demand decisions to:

1. Changes in rates;
2. Changes in transit times (service characteristics)

and to:

3. Make a preliminary assessment of the differences between long and short run demand elasticities

Demand Decisions

- Short-run Mixed/Continuous discrete decisions
  - Where to ship
  - What mode to ship by
  - How much to ship
- Long-run
  - Where to locate
  - Capacity

Decisions

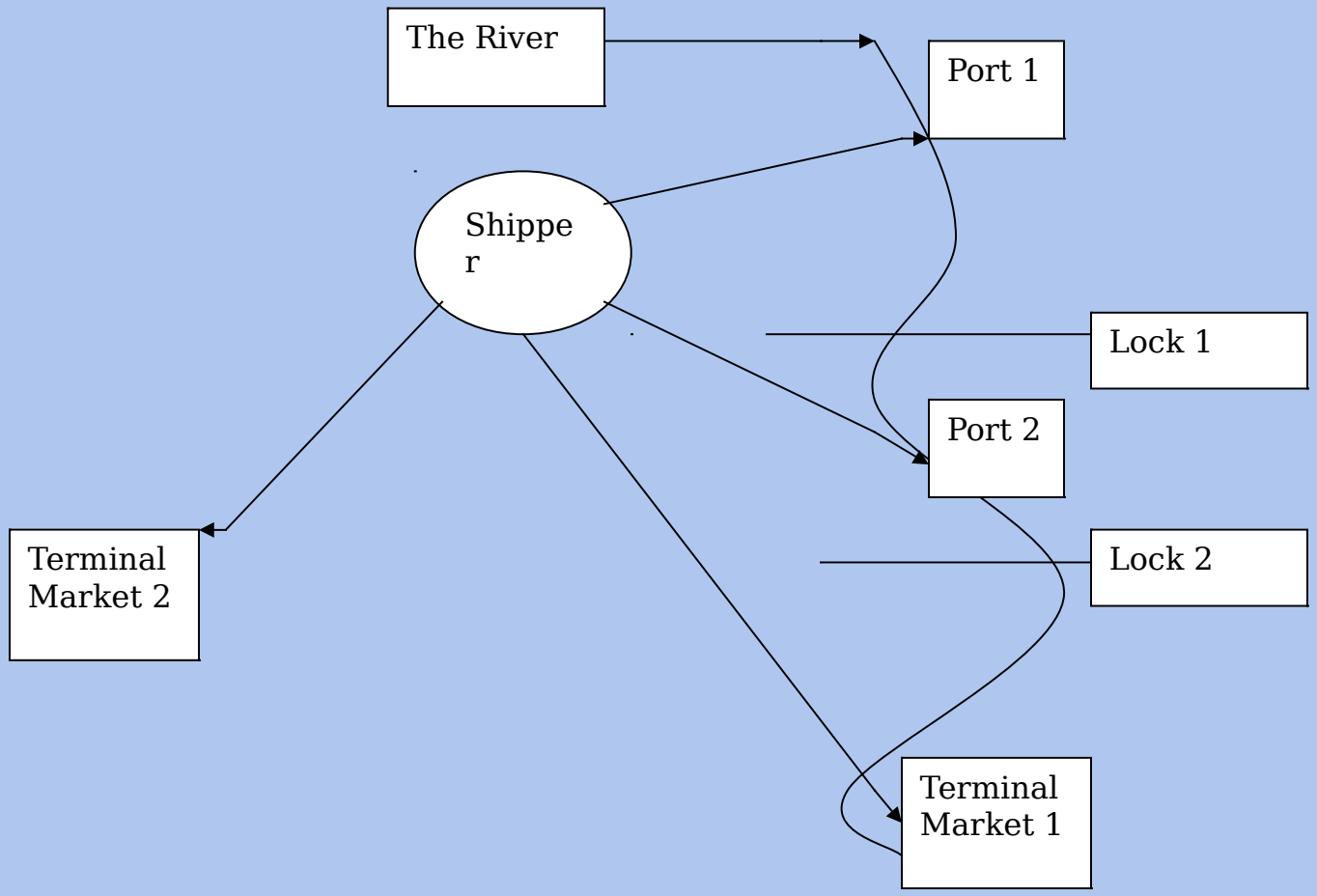
- Decisions are made on the basis of profit defined in terms of prices received (paid) for the product shipped, rate(s) of mode used, service characteristics of the mode (e.g., time in transit).
- In a discrete sense, the choice made can be characterized by:

$$p_{l,m}(P_l, r_{l,m}, t_{l,m}; X) \neq p_{l',m'}(P_{l'}, r_{l',m'}, t_{l',m'}; X)$$

l = location, m=mode *P=price received for product*
r=transportation rate *t=service characteristics*
x=other factors specific to the shipper

- Continuous decision embedded in profit equation

Enormous Number of Alternatives



Our Approach

- We frame a series of stated and revealed preference questions for use in a survey to estimate the behavioral parameters of shippers decisions.

- We ask a series of questions related to the last shipment made by the shipper, and what they would have done if that option was not available (revealed choices).

- We then change the original choice with increases in rates and service characteristics and observe whether they would switch to their alternative or not (stated preference).

History of Research

- Summer of 2003: Survey Instrument developed
- Fall of 2003: Survey instrument pre-tested and redesigned;
- November 22, 2003: OMB approval obtained.
- December 1, 2003-February 25, 2004: Survey implemented
- March 31: Preliminary draft completed

Survey

- Center for Business and Economic Research at Marshall University implemented the survey.
- Midwest Agricultural Shippers located both on and off the waterway
- Shipper list from USDA and trade associations
- 369 observations drawn primarily from States located on or neighboring states on the Mississippi and Illinois Waterway.

Elevator Locations by State (%)

State		USDA List		Survey Result	
AR			2.04		1.90
IA		12.98		7.32	
IL		13.44		33.88	
IN		3.43		3.52	
KS		10.89		4.61	
MN	6.88		7.86		
MO	3.84		7.05		
ND	4.94		3.52		
NE	7.58		7.86		
OH			4.08		3.52
OK			3.76		3.25
SD		3.09		2.71	
WI		2.52		3.25	
Other			20.53		9.64
Total Number			**6467**	**369**	

Elevators with each shipping option at their facility (percents)

Options	USDA list	Survey sample
Truck only	48.28	41.50
Truck & Barge	1.31	3.46
Truck & Rail	49.12	48.70
Truck & Rail & Barge	1.29	5.96

Commodity Shipped

Commodity	Frequency	%
Corn	219	59.35
Soybeans	26	7.05
Wheat	54	14.63
Other	70	19.97
Total	369	100.00

Rate, Time in Transit, Distance, and Size

Choice	Shipment Size (tons)	Rate per ton-mile (cents)	Miles per hour	Miles
Barge	1740	1.19	4.26	863
Rail	3.16	8.64	775	2752
Truck	12.90	34.78	123	25.2
Multi-mode	27.3	18.48	28.92	644

Note: Rates, miles per hour, and miles are averages. Shipment sizes are medians.

Alternative Choices

Alternative	Frequency	Percent
Origin Locations (mode switch)	211	57.7
Different Locations	57	15.6
Shutdown	98	26.8
Total	366	100.00

Note: Three respondents did not respond or provided incomplete or inconsistent information.

Estimation Strategy

- Current models focus on switching and the least cost alternative mode.

- Our model also focuses on switching but includes the switching not only of alternative modes but also alternative O/D based on profit relations.

Survey Information
Revealed Choices

- Shippers queried on their last shipment made:
  - Mode choice
  - Location Choice (O/D)
  - Rates, transit times, shipment sizes, and distances

- Shippers asked to identify their next best alternative (what they would do if they didn’t do what they did)
  - Mode choice
  - Location Choice (O/D)
  - Rates, transit times, shipment sizes, and distances

Survey Information
Stated Preference

- Each shipper was given a randomly drawn increase in rates and transit times, and asked if they would switch from their original choice or not.

Estimation Strategy

- Combines revealed and stated preference results.
- All choices are the result of profit maximizing decisions.
- Profit equations for the same revealed and stated preference equations share parameters.
- Profit equations for cost and time prompts share parameters.
- Estimation is by simulation.
- Results give the estimated distribution of switching rates

Model of Shippers' Choice between Two Best Alternatives

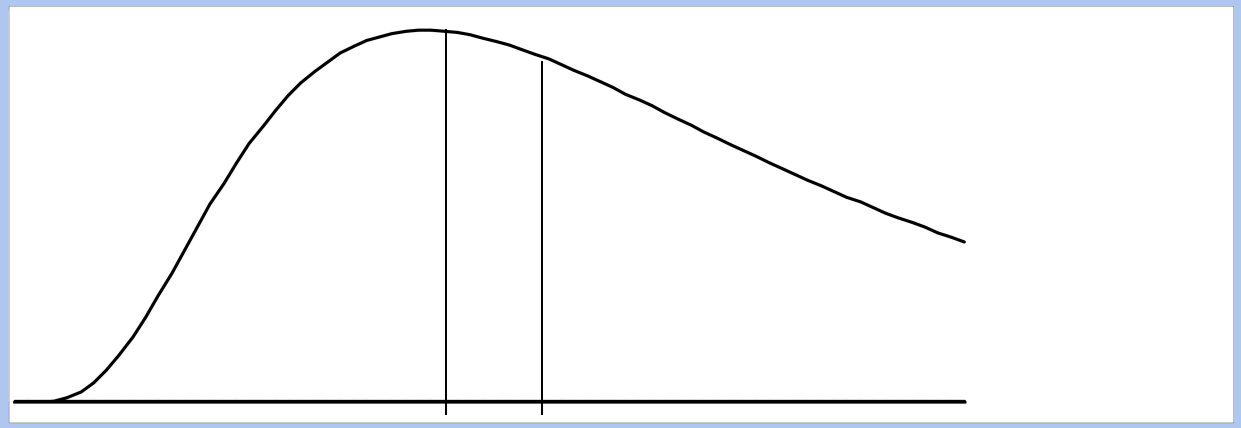
Parameters	Estimates	Std. err.	T-statistic
Median cost coefficient	-3.2436	0.3750	8.649
Mean cost coefficient	-3.9629	0.5061	7.830
Median time coefficient	-1.7942	0.1649	10.882
Mean time coefficient	-1.9232	0.1841	10.446
Shipment distance	3.3566	0.5213	6.439
Rail dummy	3.7036	0.3313	11.179
Barge dummy	4.7048	1.0167	4.627

Number of observation: 208
Mean log-likelihood at convergence: -2.40314

Summary of Results

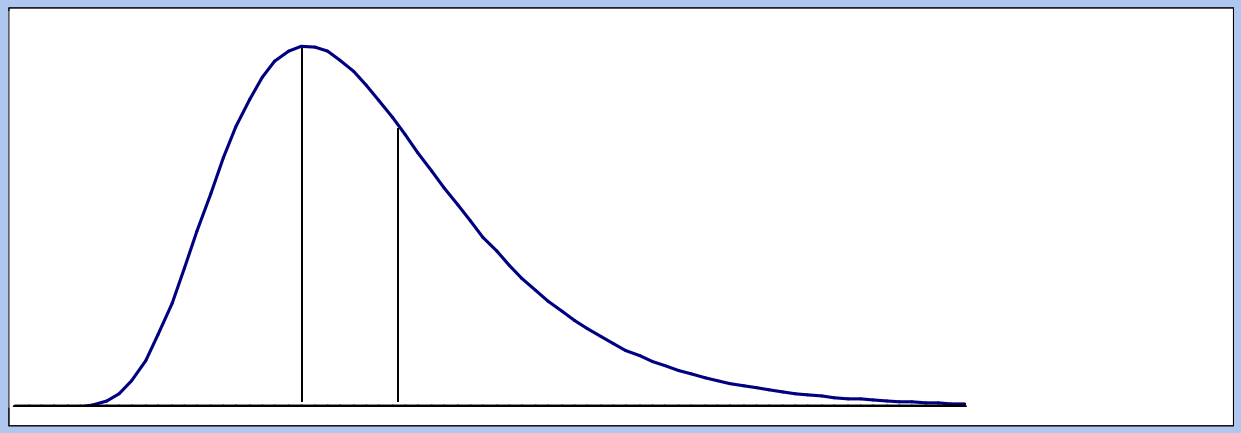
- Average Cost Coefficient is –3.96 and average time is –1.92. "Loosely speaking" rates are more important than time.
- Rail and Barge dummies reflect the choice made (truck is the base). Rail and barge are each preferred to truck *given all else is the same.*
- Time is more important for non-wheat, non-corn, non-soybean shipments
- Shipment distance (enters only if an O/D switch) is positive – shipping greater distances increases profits.
- Large increases in rates or time still have a large fraction of shippers not switching (38% for rates, 55% for time---CAPTIVE SHIPPERS

Estimated Distributions of Cost and Time Parameters



Median=3.24 Mean=3.96

Cost



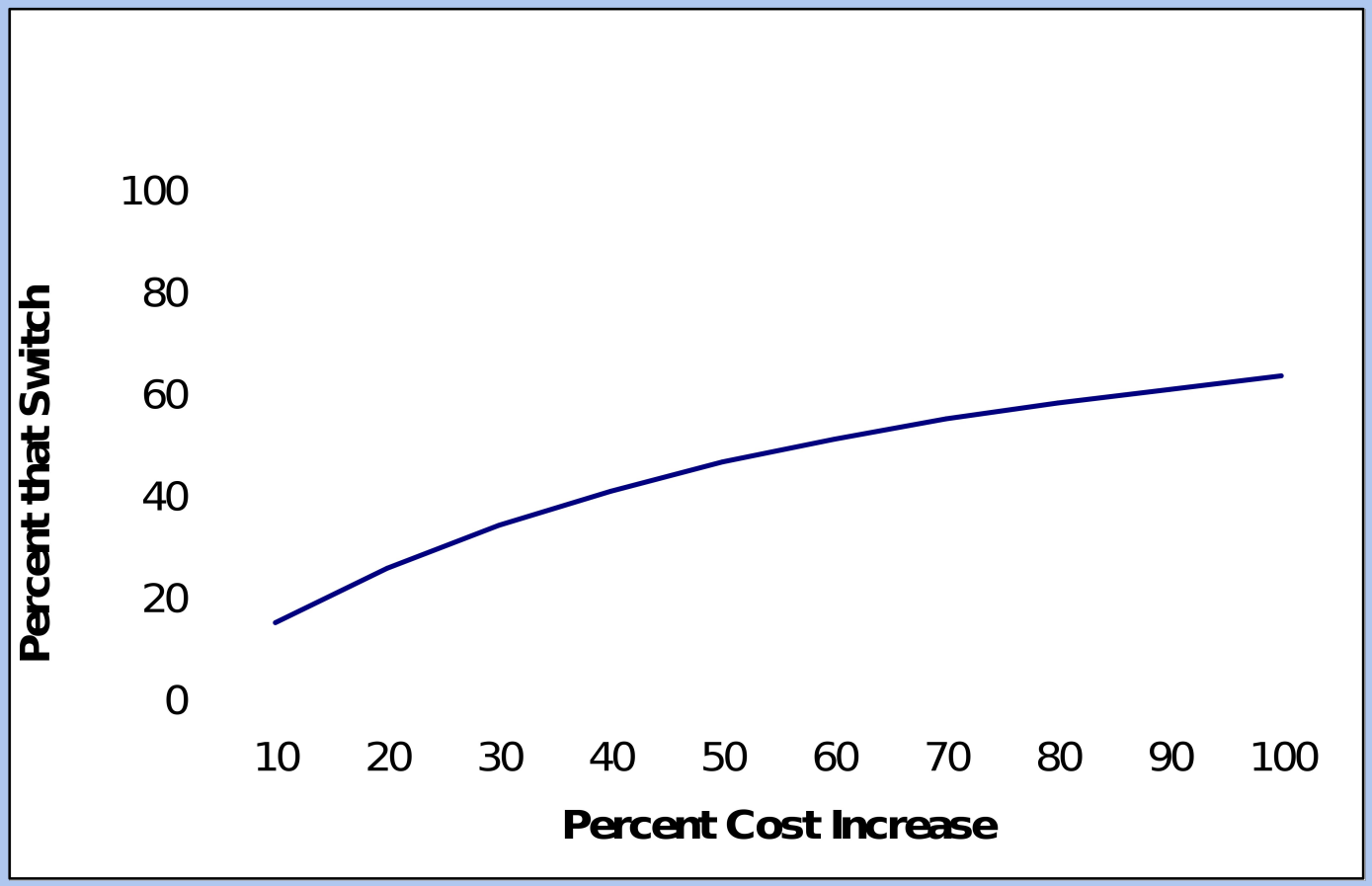
Median=1.79 Mean=1.92

TIME

Other Specifications

- Interactions of commodities and rates.
- Interactions of commodities and time.
- Whether the shipper had immediate access to barge and rail facilities.
- Shipment size.
- Level of percentage increase in cost and time necessary to switch.

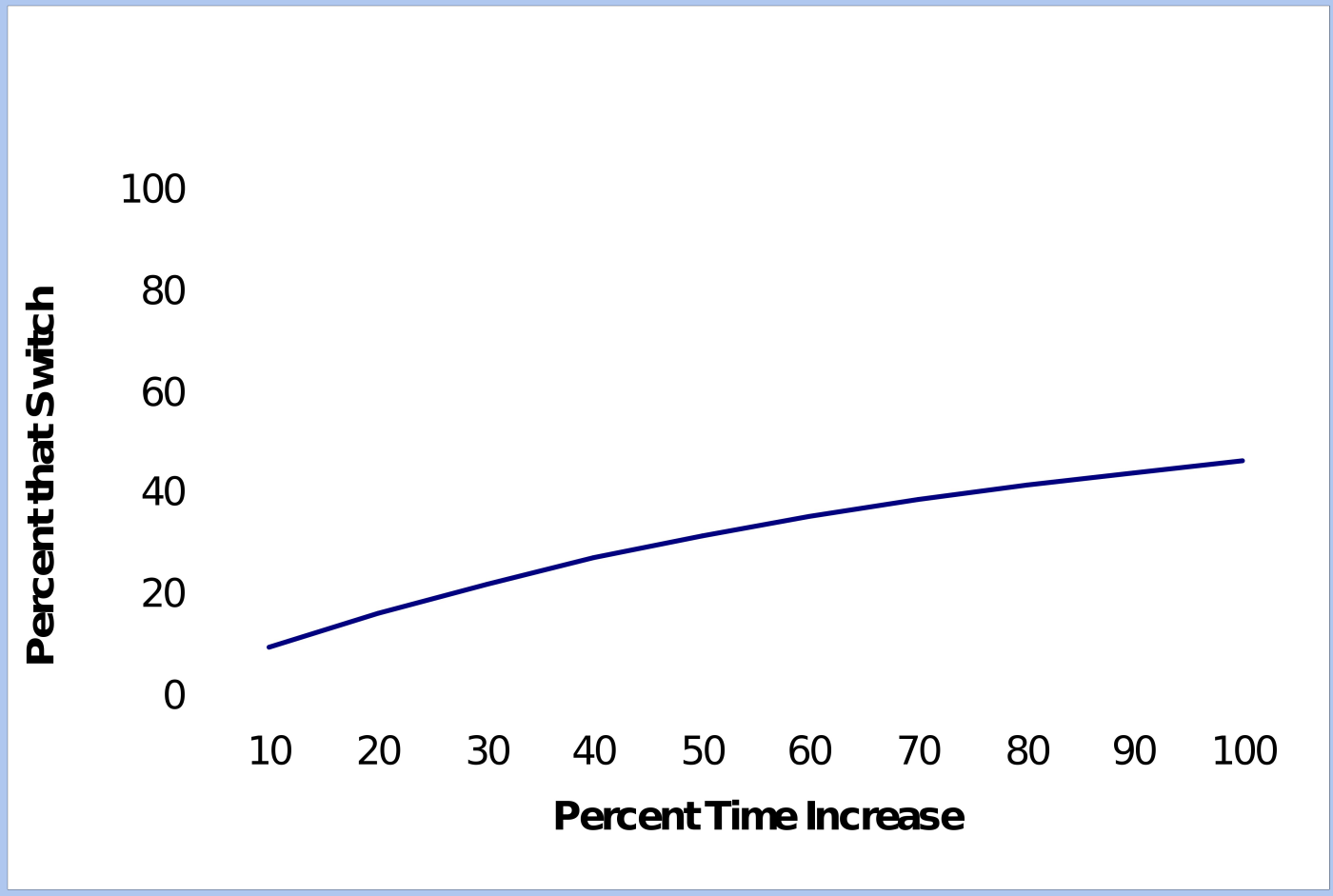
Forecasted Switch Rates



Share of surveyed shippers forecasted to switch to their best alternative if their transportation rates rise

% Cost Increase	% Switching	Arc elasticity
10	13.79	1.38
20	24.53	1.23
30	32.95	1.10
40	39.69	0.99
50	45.18	0.90
60	49.73	0.83
70	53.56	0.77
80	56.81	0.71
90	59.59	0.66
100	62.01	0.62

Estimated Share of Switches due toTime Increases



Share of surveyed shippers forecasted to switch to their best alternative if their transit times rise

% time increase	% switching	Arc elasticity
10	8.02	0.80
20	14.86	0.74
30	20.70	0.69
40	25.72	0.64
50	30.05	0.60
60	33.84	0.56
70	37.16	0.53
80	40.11	0.50
90	42.73	0.47
100	45.08	0.45

Annual Shipment Volumes

- Economic theory suggests that increases in rates or transit times will have a non-positive effect on shipment volumes.
- Results in this section are based on stated preference questions related to annual shipment volumes.
  - If rates (time) increased by XX percent, would annual shipment volumes decrease? If yes, by what percent?
    - Possibilities:
      - No
      - Yes and the percentage of decrease.

Estimation

- We model the reduction in share from a rate or time increase. The range of the dependent variable is 0 to 1. This is a two limit tobit model. Straight estimation of the model ignoring truncation gives biased results.
- Model is:

$$y = b x + e$$

$$r = \min(\max(0, y), 1)$$

Results-Rates

Variable	Estimates	Std. Err.	T Statistic
Cost increase	.8813	.1646	5.35
Transportation costs as a share of product value	.7246	.3206	2.26
Years at current location	-.00171	.00079	2.16
Barge	.0906	.0783	1.16
Constant	-.4933	.0956	5.16

Standard deviation of ε .3776 .0282

Number of observation: 353

Mean log likelihood at convergence: -0.4863

Other Specifications

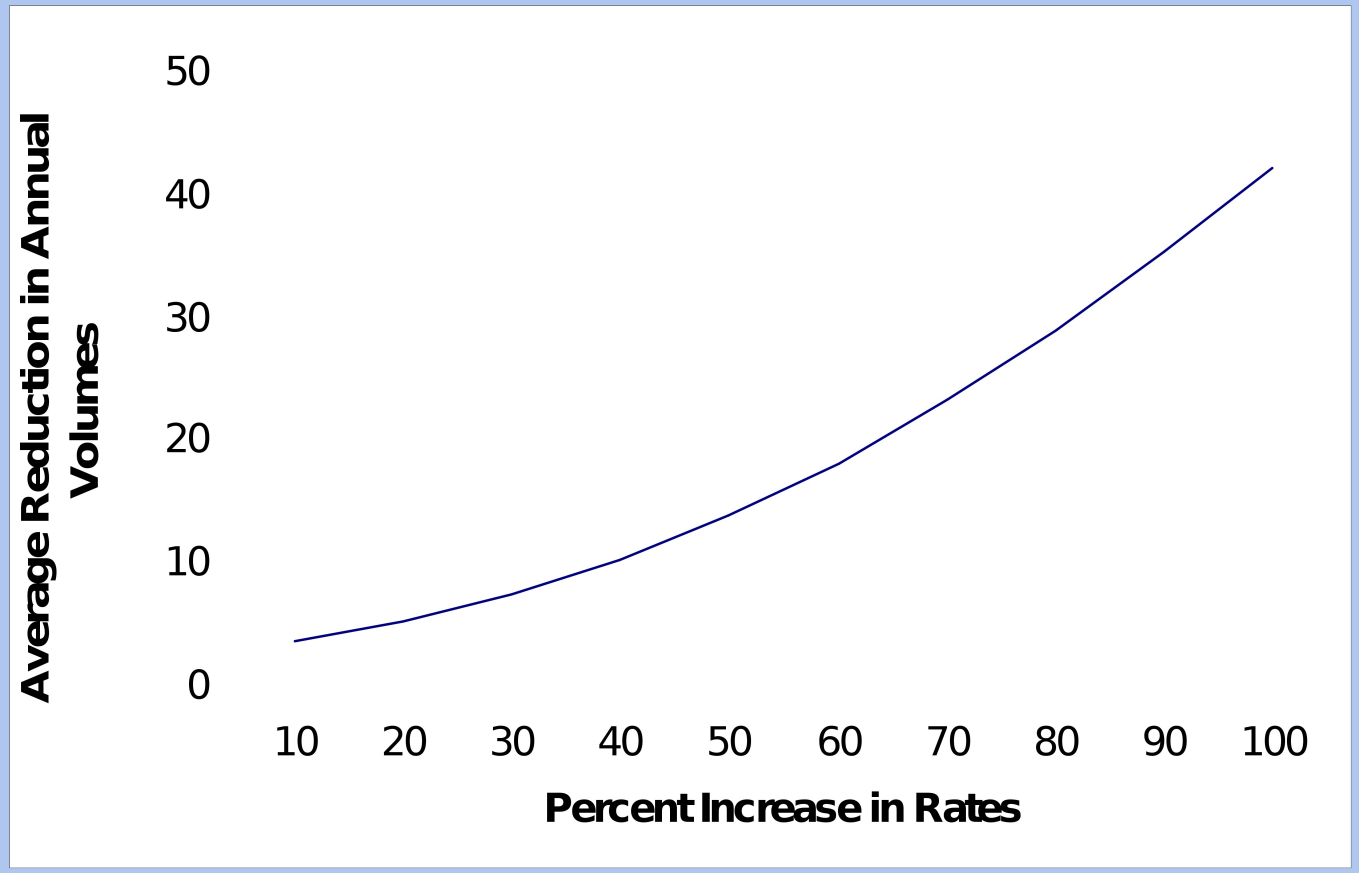
- Commodity type
- Importance of rates in location decision
- Cost increase interacted with all variables
- Ignore truncation-all estimates smaller in magnitude (as expected)

Results-Time

Variable	Estimates	Std. Err.	T-Statistic
Cost increase	.7580	.1638	4.63
Transportation costs as a share of product value	1.259	.3210	3.92
Years at current location	-.00182	.00080	2.29
Rail	.06615	.0503	1.31
Constant	-.5414	.0990	5.47
Standard deviation of ε	.3682	.0280	

Number of observation: 352
Mean log-likelihood at convergence: -0.4697

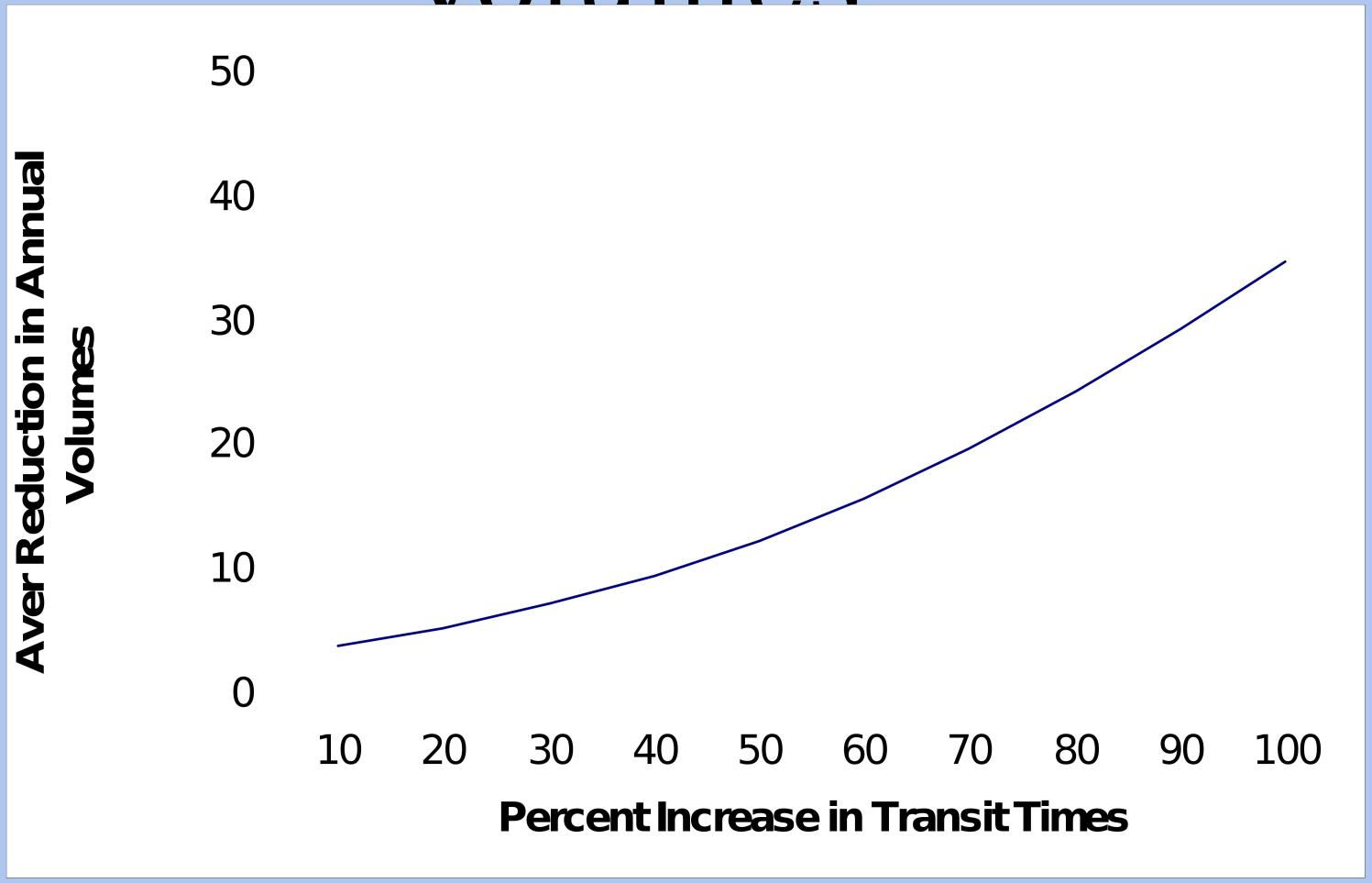
Forecasts-Rates and Volumes



Forecasts-Rates and Elasticity

Percent cost increase	Percent decrease in volume	Arc elasticity
10	3.067	0.31
20	4.655	0.23
30	6.819	0.23
40	9.652	0.24
50	13.22	0.26
60	17.55	0.29
70	22.62	0.32
80	28.39	0.35
90	34.72	0.38
100	41.49	0.41

Forecasts-Time and Volumes



Forecasts-Time and Elasticity

Percent cost increase	Percent decrease in volume	Arc elasticity
10	3.296	0.33
20	4.701	0.24
30	6.529	0.22
40	8.844	0.22
50	11.69	0.23
60	15.10	0.25
70	19.09	0.27
80	23.61	0.30
90	28.64	0.32
100	34.09	0.34

Towards an Understanding of the Long-run

- We asked a series of questions designed around long-run decision-making. Our focus is on location decisions.

Longevity of Locations

Years	Frequency	%
0-10	25	6.9
11-20	29	8.1
21-50	139	38.6
51-100	148	41.1
>100	19	5.3
Total	360	100.0

Importance of Location Decisions

Importance	Frequency	%
1 very important	233	64.54
2	44	12.19
3 somewhat important	43	11.91
4	15	4.16
5 not important	26	7.20
Total	361	100.00

Percent of Rate Decrease to Induce a Location Change

Percent of Rate Decrease	Frequency	%
1-20	17	6.07
21-40	28	10.00
41-60	41	14.64
61-80	10	3.57
81-100	15	5.36
Won’t switch at any decrease	169	60.36
Total	280	100.00

Location, Logistics and New Startups

Shippers told they were a start up business. Given a choice between locations with lower (higher) logistics costs and higher (lower) investment costs.

- 76% of shippers choose lower logistics costs and higher investment cost locations.
- 24% of shippers choose higher logistic costs and lower investment costs.

Primary Findings

- Demand has mode/location and quantity decisions in the short-run and location decisions in the long run.
- Both rates and time affect shipper’s demands.
- The elasticity of mode and O/D component of demand with respect to rates ranges from .62 to 1.38.
- The elasticity of mode and O/D component of demand with respect to time ranges from .45 to .8.
- A large share of shippers are captive and do not respond to rate and time changes (38 percent for rates, and 55 percent of for time)

Primary Findings-Con’t.

- Annual volumes do change in response to rate and time changes. Elasticities are smaller than the mode-O/D elasticities, and range in value from .23 to .41.
- Location of existing facilities is fairly insensitive to changes in costs and time (inelastic)
- Location of where to locate for new firms is highly sensitive to rates (elastic).